

## FEASIBLE STUDIES ON PRODUCTION OF BANANA POWDER

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### ABSTRACT

*In this study, banana powder was prepared by spray and tray drying processes at temperatures of 198° C & 70° C respectively. The prepared powders were analysed for physicochemical properties to assess the quality of banana powder and to evaluate relative changes in physical and chemical composition of final product during drying of banana. The various physiochemical parameters viz., moisture loss in convective drying of banana slices, total soluble solids of spray dryer feed liquid food, banana powder moisture content, bulk density, solubility, water solubility index and water absorption index, ascorbic acid content were studied. The results shown were the concentrated banana liquid feed of spray dryer maintains a (desirable 12-14) 14-18 brix, the sliced banana, both ripe and unripe banana takes same drying trend and same time (70° C, 6-7 hours) to arrive at below 10% moisture content, spray dried powders produced at 198° C have less moisture content 3.5- 4.4 % w.b. compared to tray dried powders 7.6-8.8 % w.b. produced at 70° C, the bulk density (0.41 – 0.5 g/cm<sup>3</sup>) of powder does not vary with process of making powder, the spray dried ripe banana powders are more soluble (3 min), spray dried unripe powder have more water solubility index (29.84%) and absorption index (2.4%) and spray dried and tray dried unripe powders produced at 198° C and 70° C are fairly a good source of vitamin C 10.5 mg/100g (9-11mg/100g good source). Thus, the spray dried unripe powder has more solubility index, absorption index and a good source of vitamin C and less moisture content. So, the spray drying of unripe banana for banana powder making is recommended. In the case where the spray drying machinery is not available, the tray drying of unripe banana is recommended because, the tray dried unripe powder has more solubility index, absorption index and has less moisture content compared to tray dried ripe banana.*

**KEYWORDS:** Spray Drying, Tray Drying & Banana Powder

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### INTRODUCTION

Banana is an important fruit in the world, especially of tropics and sub tropics including India. India stands second in production of banana (74,878 tons/year). It is consumed as table and culinary fruit, rich in nutrient and has many medicinal values. Also, a rich source of energy 67-137 cal/100g (Chadha, 2007). Industries like confectionery, food and beverage use banana in a powder form for production of biscuits, infant foods, and energy drinks etc. The per capita availability of banana is 42g where as the Indian council of medical research prescribed consumption requirement is 92g. As far as economy is concerned with banana production, in a situation of high yield without high income is a serious issue. Because, by the time banana reaches the consumer 20-25% of produce goes as waste due to its perishable nature. Within 2-5 days after harvest, the fruit deterioration starts due to its high moisture content 70-75%. This wastage amounts for 1300 cores (Chadha, 2007). A suitable technology for preservation of such surplus produce is imperative to develop.

Drying or dehydration is an alternative process technology which removes high moisture content and arrests water activity in food products and in turn, stops deterioration of products and increases shelf life. The selection of suitable drying process is an important factor for preserving the physical, chemical and sensory quality of the processed foods.

Keeping in view, the production rate of banana, its use in various industries in powder form and versatility of drying process technology, feasible studies for production of banana powder was initiated.

Tray drying is a commonly used drying process which removes moisture content to a great extent from highly moist foods, which is simple in operation and less expensive. Another versatile drying process is spray drying, which converts fresh liquid foods to powder in short time.

## OBJECTIVES

The main objective of this study was to produce best quality banana powder with ripe and unripe banana using simple tray drying and versatile spray drying process.

## Experimental Procedures

The raw material (both ripe and unripe banana) banana variety Poovan was procured from local market, for experimental studies. The experiments were carried out at Agricultural Process and Engineering laboratory, College of Agricultural Engineering, Bapatla and at AICRP - Post Harvest Technology Centre, Agricultural College, Bapatla.

### Tray Drying

For tray drying of both ripe and unripe banana, the fruits were peeled manually and a test sample of 300g each was taken and sliced to a uniform thickness of 7mm. The chopped slices were treated with lemon juice for 10 minutes to avoid browning. A cabinet tray dryer was used to dry banana slices. The drying temperature was 70°C. The slices were turned upside down to assure uniform drying. At every one hour of interval, the weight loss was recorded. Drying continued until the slices attained a constant weight.

The dried slices were grounded to powder using a food processor and sieved through a 2 mm mesh sieve. The powder produced was stored in a zip lock polyethylene bags.

### Spray Drying

For spray drying of both ripe and unripe banana, the fruits were peeled manually and a test sample of 300g each was taken and homogenised with 600 ml distilled water in a food processor. The homogenised blend was filtered through a muslin cloth to prepare the liquid feed stock suitable for spray drying. To reduce the stickiness of the liquid feed stock Maltodextrin (80, 90 and 100 g) was added to the test samples. Then, the total soluble solids in liquid feed stock were measured using a hand Refractometer and their corresponding brix was noted. The recommended refractive index for banana was 12° brix and 14° brix is best (Rex Harrill, 1998). A SMSE tall type spray dryer with inlet temperature 198°C, outlet temperature 100°C, feed pump with 25 RPM, blower with 2415 RPM speed and with a theoretical capacity of three litres per hour was used to dry the test sample liquid feed stocks. The time required for drying the test samples with varied Maltodextrin mix was recorded. The powder produced was stored in a zip lock polyethylene bags.

## Physicochemical Properties

The powders produced under different treatments were tested for physicochemical properties using standard

procedures described in reference Singhanat & Sertwasana (2010).

### Moisture Content

Moisture content was determined by the AOAC method. Mass loss after 5 g of each powder was placed in an oven dryer at 105 °C for 3 h was determined.

$$\text{Moisture content (w .b), \%} = \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

Where,  $W_1$  = Weight of empty box, g,  $W_2$  = Weight of moist sample + box, g

$W_3$  = Weight of bone dried sample box, g

### Water Solubility Index (WSI) and Water Absorption Index (WAI)

A small sample of dry powders (2.5 g) was added to 30 ml of water at 30 °C in a 50 ml centrifuge tube, stirred intermittently for 30 min, and then centrifuged for 10 min at (5100g). The supernatant was carefully poured off into a Petri dish and oven-dried overnight. The amount of solid in the dried supernatant as a percentage of the total dry solids in original 2.5 g sample gave an indication of the WSI. Wet solid remaining after centrifugation was dried in an oven overnight. WAI was calculated as the weight of dry solid divided by the amount of dry sample.

$$\text{WSI (\%)} = \frac{(\text{Weight of petri dish after oven drying} - \text{Weight of empty petri dish}) \cdot g}{\text{weight of powder sample taken} \cdot g} \times 100$$

### Solubility

A small sample of dry powders of 0.6 g was added to 400 ml of water at 70 °C in a 50 ml beaker. The mixture was stirred using a magnetic stirrer at 7 rpm. Solubility was measured as the time taken to dissolve the dry powders completely.

### Bulk Density

Bulk density was determined by adding 20 g of ginger powder to a 50 ml graduated cylinder and holding the cylinder on a vibrator for 1 min. The bulk density was calculated by dividing mass of the powders by the volume occupied in the cylinder.

$$\text{Bulk Density (g/cm}^3\text{)} = \frac{\text{weight of sample, g}}{\text{volume of sample, cm}^3}$$

### Ascorbic acid/Vitamin C

Dye method was used to determine the vitamin C in the test samples (Sadasivam and Manickam, 1992). About 100mg ascorbic acid (pure crystallized) was taken and made up to 100ml using 4% oxalic acid to get stock solution. The working standard solution 100ml was prepared by diluting 10 ml stock solution.

About 5 ml of working standard solution and 4% oxalic acid are pipette into a conical flask and titrated against dye solution (42 mg sodium bicarbonate and 5 mg 2, 6 dichloro phenol indophenols dye). The end point was appeared with pale pink colour which persisted for few minutes. The titration was repeated for concordant value. The amount of dye consumed determines the amount of ascorbic acid present in working standard solution.

The test sample of each i.e both ripe and unripe banana powder produce in Tray and Spray dryers was homogenised to pulp and a 10 ml homogenised pulp was taken and made up to 100 ml with 4% oxalic acid. A 5ml test sample of each was titrated against dye solution. The titration was repeated for concordant value. The amount of dye consumed determines the amount of ascorbic acid/vitamin C present in each test sample.

$$\text{Amount of Ascorbic Acid (mg/100g sample)} = \frac{0.5\text{mg}}{V_1\text{ ml}} \times \frac{V_2}{5\text{ml}} \times \frac{100\text{ml}}{\text{wt.of the sample}} \times 100$$

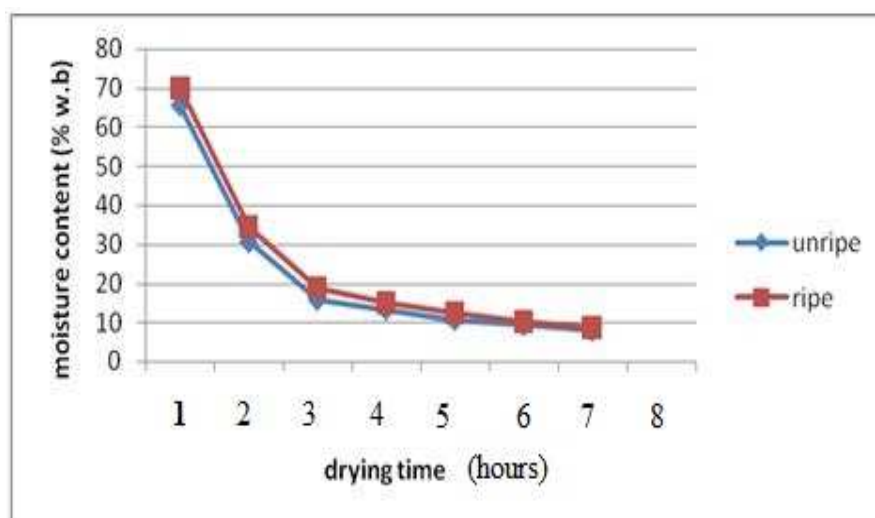
### Statistical Analysis

In all the experimental procedures as mentioned above are replicated thrice and a simple regression analysis was made to see the treatment effect on physicochemical properties of the powder produced at 95% level of significance.

## RESULTS AND DISCUSSIONS

### Tray Drying

The initial moisture content of ripe and unripe banana was 68 and 70 % (w. b) respectively. The drying rate of test samples at one hour interval was recorded.



**Figure.1: Rate of fall in Moisture Content of Ripe and Unripe Banana Slices in Tray Dryer**

The drying time to attain a constant weight in tray dried slices was 6-7 hours. The moisture content in constant weight attained slices was recorded as 10 % (w. b).

### Spray Drying

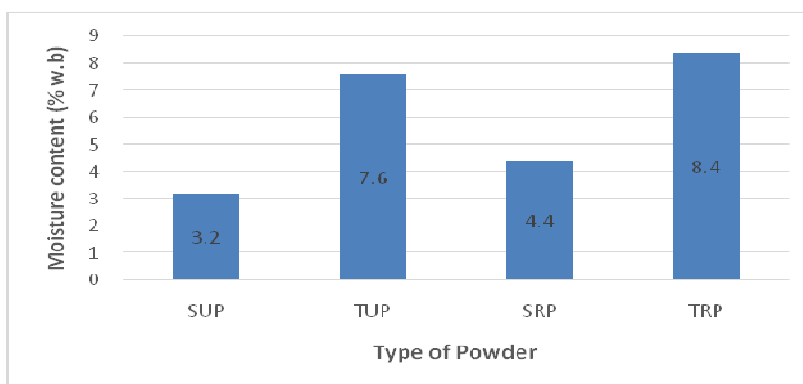
The liquid feed stock of ripe and unripe banana has refractive index of 18<sup>0</sup> and 14<sup>0</sup> brix respectively.

The liquid feed stock mixed with 100 g Maltodextrin was found to be good, as the mix resulted in free flow of throughput at the outlet of the spray dryer.

### Moisture Content

The moisture content of both ripe and unripe banana powder produced in Tray and Spray dryers were determined and found that they are 8.4, 4.4% (w.b) and 7.6, 3.2% (w.b) respectively. The same results are presented in graphical form

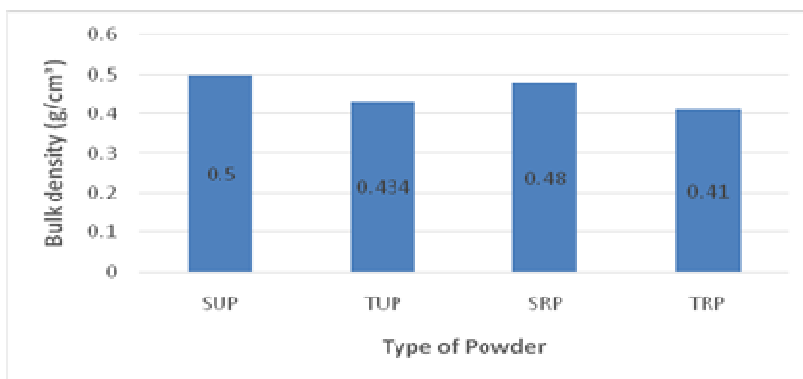
in the following fig.2. On statistical analysis, the results indicated that there is significant difference between the treatments on moisture content ( $p \leq 0.05$ ) of the banana powder with a CV 3.72 %. The significant difference in moisture content was showed by the Spray dried ripe banana powder at 95 % level of significance.



**Figure.2: Moisture Content of Banana Powder**

### Bulk Density

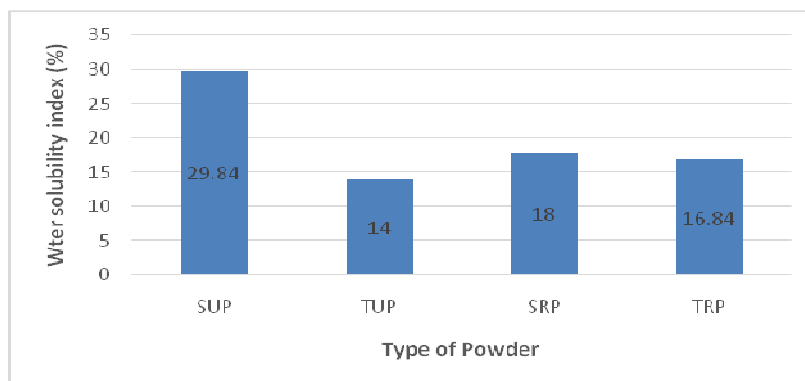
The bulk density of both ripe and unripe banana powder produced in Tray and Spray dryers were determined and found that they are 0.41, 0.43 g/cm<sup>3</sup> and 0.43, 0.5 g/cm<sup>3</sup> respectively. The same results are presented in graphical form in the following fig.3. The bulk density of tray dried unripe and ripe banana powders are 0.434 and 0.41 g/cm<sup>3</sup> respectively. On statistical analysis of replicated data, results indicated that with a CV 17 % there is no ( $p > 0.05$ ) treatment effect on the bulk density of the banana powder at 95 % level of significance.



**Figure.3: Bulk Density of Banana Powder**

### Water Solubility Index

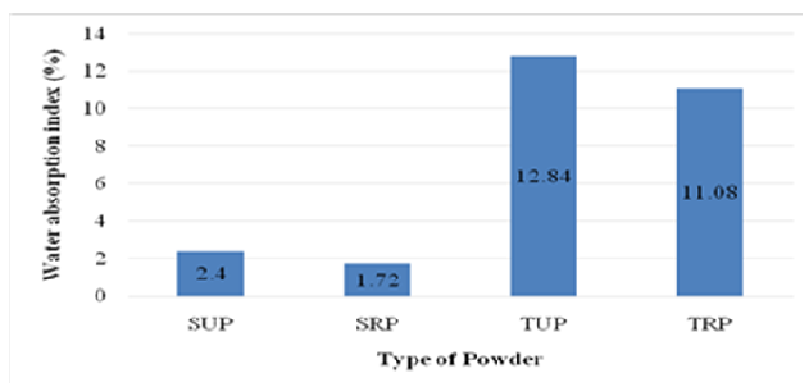
The water solubility index of both ripe and unripe banana powder produced in Tray and Spray dryers were determined and found that they are 16.84, 18 % and 14, 29.84 % respectively. The same results are presented in graphical form in the following fig.4. On statistical analysis, the results indicated that there is significant difference between the treatments on water solubility index ( $p \leq 0.05$ ) of the banana powder with a CV 5.47 %. The significant difference in water solubility index was showed in the tray dried unripe banana powder at 95 % level of significance.



**Figure.4: WSI of Banana Powder**

### Water Absorbance Index

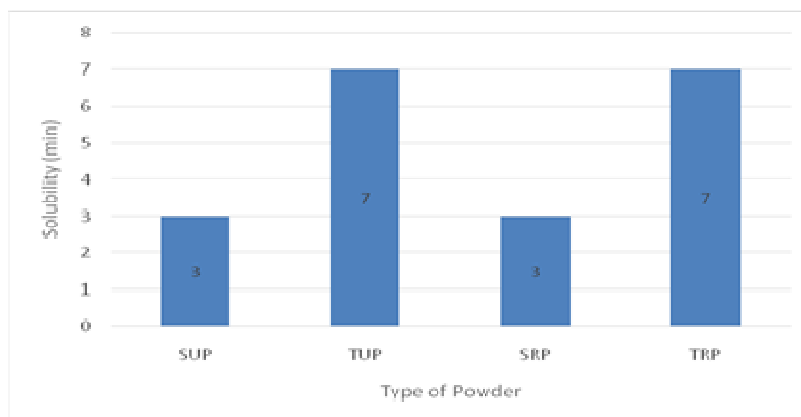
The water absorption index of both ripe and unripe banana powder produced in Tray and Spray dryers were determined and found that they are 11.08, 1.72 % and 12.84, 2.4 % respectively. The same results are presented in graphical form in the following fig.5. On statistical analysis, the results indicated that there is significant difference between the treatments on water absorption index ( $p \leq 0.05$ ) of the banana powder with a CV 8.8 %. The significant difference in water absorption index was showed in the spray dried unripe banana powder at 95 % level of significance.



**Figure.5: WAI of Banana Powder**

### Solubility

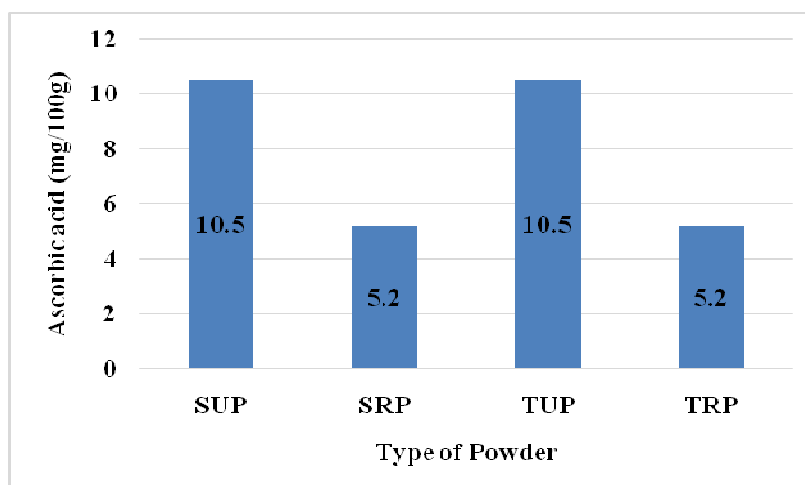
The time taken for complete solubilisation of both ripe and unripe banana powder produced in Tray and Spray dryers were recorded and found that it took 7 min and 3 min. respectively. The same results are presented in graphical form in the following fig.6. On statistical analysis, the results indicated that there is significant difference between the treatments on solubility ( $p \leq 0.05$ ) of the banana powder with a CV 9.14 %. The significant difference in solubility was showed in the spray dried ripe banana powder at 95 % level of significance.



**Figure.6: Bar Chart Showing Values of Solubility of Powders**

### Acid/Vitamin C

The ascorbic acid content/vitamin C of both ripe and unripe banana powder produced in Tray and Spray dryers were determined and found that they are 5.2 % and 10.5 % respectively. The same results are presented in graphical form in the following fig.7. On statistical analysis, the results indicated that there is significant difference between the treatments on solubility ( $p \leq 0.05$ ) of the banana power with a CV 6.53 %. The significant difference in ascorbic acid content was showed in the tray dried ripe banana powder at 95 % level of significance.



**Figure.7: Ascorbic Acid Content of Banana Powder**

### CONCLUSIONS

It is concluded that, tray drying of 7 mm thick banana slices at 70°C takes 6 -7 hours to attain 10% Moisture content. The unripe banana powder has less solubility time, more water solubility index, less moisture content, less water absorption index and is a good source of vitamin C. And while spray drying, a 100g Maltodextrin mix to the banana liquid feed will give free flow of throughput at the outlet of the spray dryer. The unripe banana liquid feed has a good refractive index of 14<sup>0</sup> brix and the powder produced has less solubility time, more water solubility index, less moisture content, less water absorption index and is a good source of vitamin C. Hence, it is recommended that, feasible process for production

of a good quality banana powder is spray drying of unripe banana and where the facility of using spray dryer is not there, the tray dried unripe banana powder production is the next best alternative.

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